



### Activities

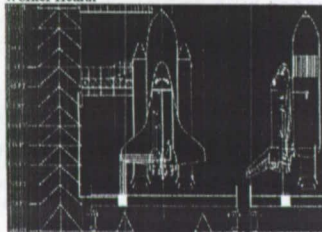
- Quantitation of Hazardous Gases in the Field
- Instrument Development
- Method Development
- Evaluate Commercial Components

### Hazardous Gases of Interest

- Explosives & Fuels
  - Hydrogen & Oxygen
  - Hydrazines
  - TNT, RDX, HMX
- Toxins
  - Hydrazines
  - Volatile Organic Compounds (VOCs)

### Gas Monitoring at KSC

- Shuttle Processing
- International Space Station (ISS) Processing
- ELV Processing
- Environmental Monitoring
- Worker Health



### Applications for Gas Analysis Systems

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>Air Quality               <ul style="list-style-type: none"> <li>Environmental</li> <li>Workplace</li> </ul> </li> <li>Leak Detection               <ul style="list-style-type: none"> <li>CRT Industry</li> <li>Refrigeration Industry</li> <li>Automotive Industry</li> <li>Food Industry</li> </ul> </li> <li>Process Monitoring               <ul style="list-style-type: none"> <li>Semiconductor</li> <li>Petrochemical</li> <li>Cross-Country Pipeline</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>Medical Analysis               <ul style="list-style-type: none"> <li>Blood Analysis</li> <li>Liver Analysis</li> </ul> </li> <li>Battlefield Threat               <ul style="list-style-type: none"> <li>Chemical Weapons</li> <li>Biological Weapons</li> <li>Land Mine</li> </ul> </li> <li>Contraband Detection               <ul style="list-style-type: none"> <li>Explosives</li> <li>Drugs</li> </ul> </li> <li>Geological Prediction               <ul style="list-style-type: none"> <li>Volcanic Eruption</li> <li>UV Hazards</li> </ul> </li> </ul> |
|---|--|

## The Hazardous Gas Detection Lab

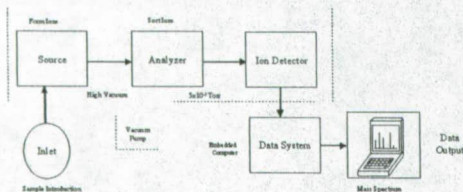
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### What is Mass Spectrometry?

Chemical analysis by transferring a charge to the molecule, separating and detecting



?Extremely Specific

?Sample Variety

?Qualitative

?Quantitative

?Rapid Response

?Large Dynamic Range

?Power Efficiency

?Weight

?Size

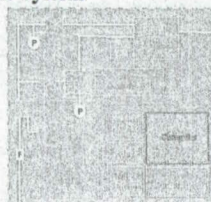
?Cost

?Ruggedness

?Operator Training

### Mass Spectrometer System

- Mass Analyzer
- Pumping System
- Power System
- Control System
- Sample Delivery
- Calibration System
- Structural Framework



### Parameters of Importance to KSC

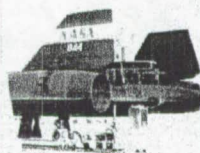
- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>Quantitative Accuracy</li> <li>Traceability</li> <li>Ruggedness</li> <li>Reproducibility</li> <li>Ease of Operation</li> </ul> | <ul style="list-style-type: none"> <li>System Size</li> <li>System Weight</li> <li>Power Efficiency</li> <li>Low Detection Limits</li> <li>Low MW Compounds - H<sub>2</sub>, He</li> </ul> |
|---|--|

### Current Strengths at KSC (for small & large systems)

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>Quantitative Accuracy</li> <li>Quantitative Traceability</li> <li>Ruggedness</li> <li>Reproducibility</li> </ul> | <ul style="list-style-type: none"> <li>Certified to Save Lives &amp; Equipment</li> <li>Ease of Operation</li> <li>Autonomous Operation</li> </ul> |
|---|--|

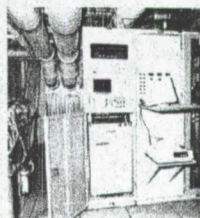
### I-HUMS

- Fixed Sector - 5 Channel
- < 30 s Response Time
- Accuracy - 10%
- LOD < 25 ppm (100 ppm He)
- In-House LabVIEW Control



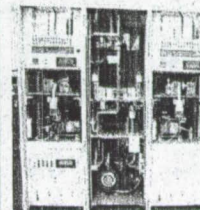
### HUMS

- Fixed Sector - 5 Channel
- < 30 s Response Time
- Accuracy - 10%
- LOD < 25 ppm (100 ppm He)
- In-House C++ Software
- Local & Remote Control



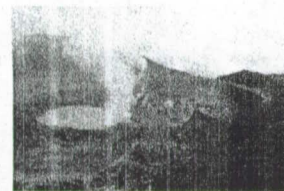
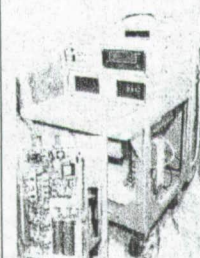
### HGDS 2000

- Linear Quadrupole
- < 30 s Response Time
- Accuracy - 10%
- LOD < 25 ppm
- Redundant Systems
- Local & Remote Control
- 1800 lbs (820 kg)



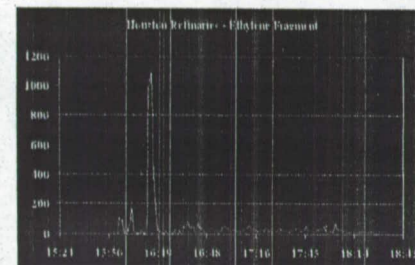
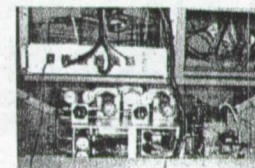
### PAMS

- Fixed Sector - Single Channel (2,3 or 4)
- < 30 s Response Time
- Accuracy - 10%
- LOD < 0.1 ppm
- In-house LabVIEW software control
- 346 lbs (157 kg)
- Disassemble to 3 parts



### AVEMS

- Linear Quadrupole
- 350 W (steady state)
- 6 s Scan Time
- 30 s Response Time
- Rugged (25 to -60°C; 760 - 50 torr)
- 47 kg (105 lb)
- 90,000 cm<sup>3</sup>
- Autonomous
- 20 ppm LOD
- Monitor 16 Gases



Detection of Hydrocarbon Pollutant when flown over refineries at ~5000 ft.

### SAMS - The Next Generation

- Linear Quadrupole
- Weight reduced; < 70 lbs
- Size reduced (Backpack Size)
- Helium LOD < 1 ppm
- Reduced Power Demand by 30%
- Improved Autonomy